Are autistic children more vulnerable online? Relating autism to online safety, child wellbeing and parental risk management

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ABSTRACT

Many autistic children are active online users. Research suggests that they are subject to distress and poor wellbeing following online safety threats. However, it is unclear if autistic children are more likely to experience online safety risks compared with non-autistic children. We conducted a parental online safety survey. Two groups of parents (autistic children, n=63; non-autistic children, n= 41) completed questionnaires about their child's online safety behaviours, wellbeing, and their own parental self-efficacy (PSE). Our results highlight that autistic children experience significantly more online safety risks than non-autistic children and poorer wellbeing than autistic children who did not experience online safety risks. Parents of autistic children reported carrying out significantly less risk management and reported poorer PSE than parents of non-autistic children. Having an autistic child and parental online safety knowledge were significant predictors of PSE. These results will help inform the co-design of interventions to protect autistic children online.

CCS CONCEPTS

• **Security and privacy~Human and societal aspects of security and privacy**

KEYWORDS

Autism spectrum disorder, online safety, internet, privacy, parental mediation

1 Introduction

Autistic children are heavy users of technology, with parents reporting them spending more time online than non-autistic children [20,34]. Challenges in this population include communication difficulties and restricted interests [2]. However, many autistic children use social media and online gaming sites for social connection and to share interests [11,16].

Despite the findings that online platforms are beneficial to autistic people, studies have suggested that this population finds it challenging to come offline and switch to another activity [24,43,46]. Mazurek and Wenstrup reported that autistic children spend higher amounts of time using online devices compared with non-autistic children [37]. Studies have reported a positive correlation between the likelihood of children experiencing online security risks and time spent online [50,51], though the latter studies did not focus on autistic children. Therefore, autistic children and young people could be considered an 'at risk' group for online safety issues, though to the best of our knowledge, no study has examined the relationship.

Thus, there are gaps in knowledge of the impact that autism might have for children's online safety. A recent critical review of autism and technology revealed that no study to date has compared online safety behaviours of autistic children vs non-autistic children [63]. From our own literature review, we found that much of the previous research on the online safety risks for autistic children is limited by the lack of a control group. This makes it difficult to determine if vulnerability to a certain risk type is "autism specific". It is important to investigate if online safety risks experienced vary between autistic and non-autistic children and how this impacts on child wellbeing. Also, it is unclear if there are differences in parental online risk management strategies and how this relates to parental self-efficacy (PSE) between parents of autistic and non-autistic children. Past studies have predominantly focused only on measuring screen time as an indicator of online vulnerability. However, these results may be ignoring other variables that could also impact the online safety risk.

The objective of our research is to investigate parental perceptions regarding the online safety behaviors of autistic children and how these compare to non-autistic children. We accomplish this with an online safety survey for parents. Through this survey, we will examine parental perceptions regarding their children's use of online platforms and safety behaviour, and how this relates to their perceptions of their child's wellbeing. We established the following research questions:

RQ1. Do parents of autistic children report their child having experienced more online safety risks overall than non-autistic children?

RQ2. Do parents of autistic children report their child carrying out less online safety risk management than non-autistic children?

RQ3. Do parents of autistic children carry out more overall online safety risk management than parents of non-autistic children?

RQ4. Do autistic children who experience a higher amount of total online safety risks have poorer wellbeing, according to the parental reports?

RQ5. Do parents of autistic children have lower parental self-efficacy than parents of non-autistic children who have experienced online safety risks?

RQ6. Is there a relationship between total online safety risks experienced and total time spent using online devices?

Our study revealed some interesting findings, some of which are counter to previous research, including evidence that screentime is not a robust predictor of children's online vulnerability.

Overall in answering these questions, our paper makes the following unique contributions:

- We contribute knowledge to the broader domain of privacy and security literature and field of interaction design for children, in relation to autism by confirming situations in which autistic children are at more risk than non-autistic children;
- We make design-specific recommendations to improve the online experiences of autistic children in terms of how they and their parents manage online risks.

2 Background

Online safety risks can be categorised into contact risks (where the child participates in risky peer or personal communication), content risks (where the child is a recipient of unwelcome or inappropriate mass communication), and conduct risks (where the child acts themselves to contribute to the risky contact or content) [19, 64]. Examples of contact risks include sexual grooming and cyberbullying. Content risks cover phishing attacks and downloading harmful malware, while conduct risks include, but are not limited to, inappropriate posting and unauthorised spending.

2.1 Contact Risks

There is evidence that contact risks are particularly relevant to the autistic population. Psychological theories posit that autistic and non-autistic people have difficulties understanding each other, which can lead to breakdowns in two-way social interactions [40]. Many autistic young people use social media to communicate with others [11,37] with some autistic people stating a preference for online versus face to face communication. Reasons for this preference include control over the pace and increased comprehension of online social interactions [11]. It is possible that time spent online and a reliance of online rather than offline communication may increase the risk of cyberbullying. Cyberbullying is thought to be more prevalent among the autistic population than other forms of bullying. A review which included children with various disabilities, including autism and examined rates of all types of bullying, suggested that autistic young people are twice as likely to be victims of cyberbullying versus non-autistic counterparts [52]. However, the review and past studies have focused on rates of traditional bullying as opposed to cyberbullying and examined children with various disabilities [12,29]. This makes it difficult to determine if an increased vulnerability to cyberbullying is autism specific.

Online sexual grooming/exploitation is a growing area of concern regarding autistic children. Numerous surveys have shown a near double increase in prevalence of sexual abuse among victims with disabilities than those without disabilities [35,48]. This suggests that autistic children may be at a higher risk of online sexual exploitation. One qualitative study used semi-structured interviews with 6 autistic women aged 19-29 years. Key themes from the interviews included relationship violence and abuse, child sexual exploitation and rejection. Half of the women had experienced physical emotional and sexual abuse or threats from men that they had been romantically involved with, including one experiencing online grooming and child sexual abuse [25]. These posit that autistic children may be vulnerable to sexual exploitation/violence. However, the above studies were conducted only with a small number of adult females so it is unclear if the same pattern exists for autistic children.

Online dating by autistic adults was studied by Roth and Gillis [53]. Of their 17 autistic interviewees, around half had tried online dating. However, the autistic participants reported drawbacks, including concerns about online safety. The authors reported that the autistic participants tended to be overly trusting, found too much choice to be overwhelming and found communication to be harder online. This sample size is too small to generalise to the general autistic population, and there was no control group to compare whether reported concerns were autism specific, or common to all online daters. A recent sample of women found that 79% of autistic women had reported having suffered sexual exploitation or abuse compared with 26% of non-autistic women [58]. To date, no study has directly compared the rates of online sexual grooming/exploitation between autistic and non-autistic children. This makes it difficult to determine if this online safety issue is ‘unique’ to autistic children and young people.

2.2 Content Risks

However, it is possible that not all online safety risks are necessarily more prevalent in the autistic population. Previous research suggests that content risks, such as phishing, may occur to a similar degree in autistic and non-autistic children. Phishing or hacking involves the “unauthorised use of, or access into, computers or network resources, which exploits identified security vulnerabilities in networks” [39]. Being able to spot hacking or phishing attempts relies on identifying particular visual cues from the website or link that appears fake. Perceptual theory models put forward that the perceptual systems of autistic people may out-perform their non-autistic peers [42]. Data from visual search tasks reveal that autistic people demonstrate particular strengths for the most difficult, conjunctive search tasks [60]. These skills may make autistic people less susceptible to hacking or phishing attempts. Indeed in a recent study comparing 15

autistic adults with 15 non autistic adults no differences in detecting phishing were found between the two groups. Both groups were able to successfully distinguish between real websites from fake counterparts [44]. Previous studies have been conducted with adults, it is therefore important to determine if this is also the case with children. It is possible that the perceptual abilities in some autistic children will make them less prone to succumbing to certain online safety risks such as phishing than others.

2.3 Conduct Risks

Nonetheless, there is evidence that autistic children may be subject to "conduct" risks. This category covers incidences where the child acts themselves to contribute to the risky contact or content. Just and Berg [22] reported on the results of two workshops with 16 parent carers of children on the autism spectrum in which they used pictures and group discussions to identify carers' concerns. Risks experienced included unauthorised purchases and inappropriate posting on social media sites. The workshop did not include the perspectives of parents of non-autistic children. Thus, we cannot fully determine if autistic children are more vulnerable to examples of online conduct risks without a control group. Nevertheless, these findings suggest that protecting the online safety of autistic children is challenging for parents.

2.4 Managing Online Risks

Online safety risks are suggested to have negative consequences for child wellbeing. Studies have found that autistic adolescents and those with disabilities were more likely to report distress following cyberbullying victimization compared with non-autistic peers [70]. This corresponds with evidence that cyberbullying victimization and peer rejection is associated with depression and anxiety in autistic adolescents [72,73]. The research emphasises the negative impact that online safety risks have for autistic children's wellbeing.

Parental mediation has been identified as a key protective factor against harm resulting from negative online experiences [32]. Therefore, it is important to examine parent online risk management of autistic children. Many parents of autistic children restrict their childrens' online use via parental apps or switch off and remove device(s) [5,57]. However, there is a debate as to how justifiable apps are as they often involve a compromise between a reduced likelihood of experiencing risks online and limiting children's independence [31, 10]. Given the methodical nature often reported in autism [23,60] and evidence that many autistic children are particularly adept with computers and other online devices [47], it is possible that such software may be overused or not readily accepted by autistic children compared with non-autistic children. In contrast, nudging solutions, for example one that reminds users about the audience for their social media post might allow users to consider potential risks whilst independently browsing the internet [1,69]. However, no research to date has examined their effectiveness or efficacy in the autistic population.

Parental Self Efficacy (PSE) can be defined as the expectation caregivers hold about their ability to parent successfully [64] and positively correlates with parent and child adjustment (21). Many parents experience difficulties trying to protect their children online. Evidence suggests that they find it socially and technically challenging for which they feel ill-equipped and under-resourced to administer [30]. Therefore, many parents are challenged by the task of protecting their children's safety online, and thus will be likely to have lower parental self-efficacy (PSE). To date, no research has examined the relationship between PSE and online safety incidents in autistic children. Just and Berg [22] described that many of the parents reported that they lacked the confidence and skill to deal with risk scenarios when they arise, so it is likely that parents of autistic children will feel less equipped to manage their online safety. An international survey of 388 parents of autistic children revealed that concerns with their child using technology positively correlated with the child's screen time [26]. Based on evidence that many autistic children are active online users, it is likely that their parents will be apprehensive about the amount of time their children spend online. Parents may be worried that technology use detracts from or replaces "real life" interaction [67]. Alternatively, parents may lack the skills needed to tackle the technical aspects of online safety protection [30]. Therefore, parental online safety knowledge is likely to affect their parental online risk management and their PSE.

Evidence above suggests that parents of autistic children are more likely to have poorer PSE, though the studies lacked a control group. Taking the previous studies into account, it is likely that parental online safety knowledge will negatively relate to PSE, particularly among parents of autistic children. If PSE were to relate to parent risk management, digital interventions can be designed to help improve PSE with regards to online safety.

2.5 Context and Motivation

Previous research has predominantly measured only time spent online to gage people's online behaviors [6,38,65]. However, estimates of time may be confounded by simultaneous use of multiple devices [61]. Having a sole focus on screen time fails to consider how children use online devices and if other important factors such as child age or pre-existing conditions influence the likelihood of encountering online safety risks. For example, online device use has been reported to increase with age [50,51]. Children access the internet from mobile devices at increasingly younger ages [36]. Zhao et al [74] conducted focus groups with children aged 6-10 years and presented various online safety scenarios. The children showed awareness of certain online risks e.g. who might access their sensitive information and were able to suggest a range of techniques to safeguard this space e.g. verifying identities through face-to-face interactions or avoiding using real names as usernames. Therefore, it is important to investigate online safety behaviours among younger children as they access online content and have an awareness of online safety risks so should be included in research.

In addition, research points towards a third to two-thirds of autistic children and adults having a co-morbid Learning Disability (LD) [4,8,45] and/or Attention Deficit Hyperactivity Disorder (ADHD) [27]. Past studies which failed to categorize autistic children into groups depending on whether or not they have a comorbid condition may have masked a potential effect of having a condition such as ADHD/LD on an autistic child's online vulnerability. Therefore, it is important to control for these to examine if higher incidents of a particular risk are unique to autistic children and young people.

It is possible that these factors may be more robust predictors of online safety risks experienced. This study will assess for these variables to investigate if increased vulnerability to online risks is "autism" specific.

Little research has examined autistic children's online safety experiences. With regards to autism and technology interventions, authors have highlighted issues, particularly a lack of efficacy and ecological validity [9,66]. It is crucial that these are investigated before recommending the design of digital tools.

Previous studies have investigated single types online safety in the autistic population to varying extents. However, the majority are limited by a lack of a control group. From our extensive literature search, no studies to date have compared the rates of multiple online risk incidents in autistic children. By comparing these with a sample of non-autistic children, we will examine if autistic children experience more online safety risks overall or if they are vulnerable to certain online risks.

Past research on content and media preferences has focused specifically on adolescents [36] or has not reported the age of participants [59]. Considering that online risks positively correlate with child age, we have collected data regarding this.

To date, online device research has largely focused on self-reporting by autistic adolescents and adults [8,19]. However, solely relying on self-report measures would exclude the large number of people on the autism spectrum with limited verbal abilities [68]. Parental surveys are considered to be a useful medium for gathering rich information about autistic young people's online device use [26]. To the best of our knowledge, this will be the first study to compare parent's reporting online risks among autistic and non-autistic children.

3 Methods

3.1 Design

Our survey compared two groups: parents of autistic children and parents of non-autistic children aged 6 years and over. The dependent variables included: the total time spent using online devices and the total child online safety risks experienced. The survey was supplemented by questions examining reasons for online device use, child online safety awareness; child and parent online safety risk management, child wellbeing and parental self-efficacy (PSE).

3.2 Procedure

Ethical approval was obtained from the [REMOVED FOR BLIND REVIEW] Ethics Committee. The survey was delivered via 'Qualtrics' online survey platform. Participants were invited to read an information form about the study, and to agree with the consent statements if they wished to take part. It was emphasised that

participants could withdraw at any time. They were then directed to the survey questions. This was followed by a debriefing form where and contact details for suitable mental health and autism support organisations were provided and participants were invited to provide their contact details if they wished to receive a summary of the results or take part in future research. Participant contact details were segregated and stored separately from anonymised survey responses. All of the participant data were stored in password protected databases, which is only accessible by the research team.

3.3 Materials

There were four sections in the survey. Parents with multiple children were asked to respond for only one of their children.

Section 1 measured demographic variables including parental age, child age, child gender as well as asking if the child had a diagnosis of autism and or other conditions, including a Learning Disability (LD) and ADHD. For example, "For the child that you've chosen for your responses to this survey, would you identify this child as being on the autism spectrum?". If they clicked "Yes" they were directed to further questions which asked them to verify the age that their child had received their diagnosis and if their child had been diagnosed by a medical professional.

Section 2 asked parents about their child's online device use. Participants were invited to indicate their child's access to various online devices. Examples were given along with a description, e.g. Tablet (e.g. iPad, Android). Parents were also asked how many hours that they thought their child spends using each device on an average day.

Section 3 focussed on the child's online safety behaviours. Examples of contact, content and conduct online safety risks [19, 64] were listed along with descriptive examples of each. For example, "Phishing/scamming (e.g. clicking on links to fake, lookalike websites)". An "Other (please describe)" box was provided to ensure coverage of all types of risks experienced online. Participants were asked to click "Yes" or "No" to any risks that their child had experienced and strategies which they used to keep themselves safe online e.g., "Relies on internet safety software". The total number of "Yes" clicks from each online safety risk section were summed together to give a total online safety risks experienced category. Similarly, parents were given a list of child online risk management strategies. For example, "He/She avoids or blocks people and/or online sites" and asked to click "Yes" or "No" to give a total for the child online risk management variable. Examples of online safety risks experienced and risk management strategies were taken from previous research in this area [22]. For each question, parents also had the option of responding that they were unaware of their child's safety behaviour.

Section 4 assessed parental risk management. Parents were given a list of parent online safety risk strategies. For example, "Monitor online access via parental controls (e.g. Net Nanny, Boomerang)" and asked to click "Yes" or "No". These were summed to give a total parent risk management variable. Sections 2-4 of the survey also asked participants to respond to statements about their attitudes to their childs online device use with a five-point rating scale from "Strongly Disagree" to "Strongly Agree". Examples included "I believe that he/she has benefitted from using online devices".

The Strengths and Difficulties Questionnaire (SDQ) [13] consists of 25 items that form five subscales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationships, and prosocial behaviour) was used to measure child wellbeing. As part of the SDQ, parents were asked to rate statements about their child such as "Often unhappy, down-hearted or tearful" on 3 point Likert scale that ranged from "Not True" to "Certainly True". Scores on each subscale ranged from 0 to 10. The SDQ total score is calculated by summing the subscale scales together, apart from the prosocial scale. Total scores range from 0 to 40. Higher total scores point towards poorer child wellbeing. Studies have indicated that it distinguishes between children with and without psychiatric disorders [14,15,55] is a reliable scale for measuring wellbeing among typically-developing children and autistic children [54,56].

To measure parental self-efficacy, we used the 4-factor scale of Hamilton et al. [17]. This scale measures global beliefs about self-efficacy, personal agency, self-management, and self-sufficiency. Parents were asked to rate 16 statements from "Strongly Disagree" to "Strongly Agree" on a 5 point Likert scale. Higher scores indicate higher levels of each construct, with the exception of personal agency. Personal agency scores are reversed to compute the total score with the sum of the other sections. Scores can range from 16 to 80 on

the total scale, and 4 to 20 on each of the subscales. Moderate to high internal reliability has been demonstrated across the subscales (.45- .75) [17].

3.4 Content Risks

However, it is possible that not all online safety risks are necessarily more prevalent in the autistic population. Previous research suggests that content risks, such as phishing, may occur to a similar degree in autistic and non-autistic children. Phishing or hacking involves the "unauthorised use of, or access into, computers or network resources, which exploits identified security vulnerabilities in networks" [39]. Being able to spot hacking or phishing attempts relies on identifying particular visual cues from the website or link that appears fake. Perceptual theory models put forward that the perceptual systems of autistic people may out-perform their non-autistic peers [42]. Data from visual search tasks reveal that autistic people demonstrate particular strengths for the most difficult, conjunctive search tasks [60]. These skills may make autistic people less susceptible to hacking or phishing attempts. Indeed in a recent study comparing 15 autistic adults with 15 non autistic adults no differences in detecting phishing were found between the two groups. Both groups were able to successfully distinguish between real websites from fake counterparts [44]. Previous studies have been conducted with adults, it is therefore important to determine if this is also the case with children. It is possible that the perceptual abilities in some autistic children will make them less prone to succumbing to certain online safety risks such as phishing than others.

3.5 Hypotheses

For each of our six research questions we established a corresponding hypothesis.

This project will examine if parents of autistic children perceive them to be subject to more overall online safety risks, or certain types more than non-autistic children. From the few studies conducted, the findings suggest that the former are more likely to experience risks that involve direct contact such as cyberbullying [52] and less likely to be subject to less socially direct ones such as phishing [44]. Given these findings, the first hypothesis (H1) predicts that:

H1. Autistic children will experience more contact and conduct risks, but less content online safety risks than non-autistic children.

This study will investigate if there is a difference in the total online safety risk management carried out by autistic and non-autistic children, according to the parents. From the few studies investigating autistic online safety, it has been suggested that autistic children can be "naïve" to online safety risks [22]. Based on these findings, our second hypothesis (H2) states that:

H2. Autistic children will carry out less overall online safety risk management than non-autistic children.

Parental online safety risk management will be compared between autistic and non-autistic children. Previous research suggests that parents will restrict or switch off devices to protect their children online, including those who care for autistic children [4,51]. However, there is no concrete evidence as to whether parents of autistic children engage in more parental online safety management than those of non-autistic children. The third hypothesis (H3) will be open-ended:

H3. There will be a difference in total parental online safety management between parents of autistic and non-autistic children.

It will be investigated if autistic children with higher total online safety risks have lower wellbeing scores than autistic children with lower online safety risks. Online device usage among autistic children will be split into "high" and "low users" and SDQ scores will be compared. Previous studies suggest an increased vulnerability online positively correlates with poorer wellbeing outcomes in autistic young people [72,73]. Our fourth hypothesis (H4) thereby suggests that:

H4. Autistic children who have higher total online safety risks will have lower SDQ scores than autistic children with lower total online safety risks.

This study will contrast PSE of parents of autistic and non-autistic children. Many parents of autistic children report difficulties trying to protect them online [22]. Taking into account that parents report difficulties trying to protect their children online as they find that they are socially ill-equipped and under-resourced to do [30]

and many autistic children struggle to transition offline to online [23,43,46], our fifth hypthesis (H5) states that:

H5. Parents of autistic children will report lower PSE than parents of non-autistic children and variance will be accounted for by differences in child online safety risks predicted.

The survey will compare total screentime and online safety risks among autistic and non-autistic children. Given that past research posits a positive correlation between the likelihood of children experiencing online security risks and time spent online [50,51]: our sixth hypothesis (H6) indicates that:

H6. There will be a positive correlation between total online safety risks experienced and total time spent using online devices.

4 Results

4.1 Participants

We recruited 104 parents aged 27-54 (*M*= 40.16, *SD*= 8.73) in the United Kingdom. The sample included 63 parents aged 28 to 54 years (*M*= 39.45, *SD*= 9.90) of autistic children. The control group was made up of 41 parents aged 27 to 52 years (*M*= 41.22, *SD*= 6.70) of non-autistic children. Our exclusion criterion was children under the age of 6 years. Based on evidence that many autistic young people continue to live in the same household beyond the age of 16 years [28], no upper child age limit was set. For our survey, parents of children aged 6-22 years participated. Child demographics are displayed in Table 1. We invited parents of autistic as well as non-autistic children via social media, including

Table 1. Child Demographics

		Autistic Children (n=63)	Non-Autistic Children (n=41)
Child Gender *Count*	Male	51	18
	Female	10	24
	Other	1	0
LD *count*		20	5
ADHD *count*		15	0
Age *Mean (SD)*		11.35 (3.71)	11.31 (3.38)
Min-Max		6 – 22	6 – 17

Facebook and Twitter. In addition, parents of autistic children were approached by contacts with relevant organizations such as the *<removed for anonymity of submission – will be included if paper is accepted>*.

4.2 Statistical Analysis of Research Questions

Below, we answer our research questions by analyzing our survey data.

RQ1. Do autistic children experience more online safety risks overall than non-autistic children?

An Independent T-Test was used to compare the total online safety risks experienced by autistic and non-autistic children, as reported by their parents. Autistic children experienced a significantly higher amount of overall online safety risks (*M* = 0.76, *SD* = 1.03) than non-autistic children (*M* = 0.39, *SD* = 0.67), p = 0.027, d = 0.4, confirming the hypothesis, though with a small effect size.

Chi-Square Tests were used to investigate if having autism was related to the "type" of online safety risk experienced. There were significant associations between having autism and unauthorised online purchases, $\chi 2$ (1) = 4.28, p = 0.039. Based on the odds ratio, the odds of buying goods/services online were 4.61 higher if the children were autistic than if they were non-autistic. No significant associations were found between having autism and the other types of online safety risks experienced (see Table 2).

A One-Way ANOVA was conducted to investigate if autistic children with LD and/or ADHD experienced more online safety risks than autistic and non-autistic children without LD/ADHD.

Autistic children with LD/ADHD (n=32, M=0.34, SD=0.70 experienced fewer online safety risks than non-autistic children (n=37, M=0.65, SD=1.03) and autistic children (n=31, M=0.81, SD=0.946). However, there was no significant main effect of group on total online safety risks experienced, F(2, 99)= 2.115, p = 0.126, η^2= 0.04.

Table 2. Chi Square Tests of Online Safety Risks Experienced According to Type

Online Safety Risk Experienced	Pearson Chi Square χ2
Phishing/Hacking	0.411
Downloading Harmful Malware	3.595
Sexual Grooming/Exploitation	0.048
Cyberbullying	0.145
Buying goods services/online	4.281*
Other	0.370

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$*

RQ2. Do autistic children carry out less online safety risk management than non-autistic children?

An Independent T-Test was used to analyze if there was a significant difference in total online safety risk management strategies carried out between autistic and non-autistic children. Autistic children carried out less overall online safety risk management (M = 1.29, SD = 1.07) than non-autistic children (M = 1.63, SD = 1.07), d = 0.3. This confirms our hypothesis with a small effect size. However the difference was non-significant, p = 0.107.

Chi-square Tests were used to investigate if having autism was related to the "type" of online risk management strategy used.

These are shown in Table 3. There were significant associations between having autism and blocking people and/or online sites, with just over a third of the autistic group blocking people and/or online sites, compared with approximately two thirds of non-autistic children $\chi 2$ (1) = 9.54, p = 0.002. Based on the odds ratio, the autistic group were 4.88 times less likely to block people and/or online sites than the non-autistic group. Having autism was significantly associated with "does not use any strategies", $\chi 2$ (1) = 4.739, p = 0.029. Moreover, the autistic group were 7.52 times less likely to use strategies to protect themselves online compared with the non-autistic group. No significant associations were found between having autism and the other types of online safety risks experienced.

RQ3. Do parents of autistic children carry out more overall online safety risk management than parents of non-autistic children?

An Independent T-Test was used to analyze if there was a significant difference in overall parental online safety risk management between parents of autistic and non-autistic children. Parents of autistic children reported significantly less overall parental online safety management (M = 1.43, SD = 1.87) than parents of non-autistic children (M = 2.15, SD = 1.51), p = 0.008, d = 0.5, with a mid-range effect size.

RQ4. Do autistic children who experience a higher amount of total online safety risks have poorer wellbeing?

A Two-Way ANOVA on group (autistic versus non-autistic children) and online safety risk group (no risks versus one or more online safety risks experienced) revealed a significant main effect of group, F(1, 100) = 26.149, p = 0.000, η^2 = 0.395, such that autistic children had higher SDQ total scores on the whole, compared with non-autistic children and the effect size was large. There was a significant main effect of online safety risk group, F(1, 100) = 10.571, p = 0.002, η^2 = 0.096, such that children who experienced one or more online

safety risks had higher SDQ total scores than children who experienced no online risks and the effect size was in the mid to large range. There was no significant group by online safety risk group interaction: both groups scored a similar mean difference between SDQ scores for high and low risk groups, $p = 0.658$, $\eta^2 = 0.002$, with a small effect size. Group Differences in SDQ scores are displayed in Figure 1.

Follow-up Independent T-Tests were used to check if there were significant differences in SDQ scores groups. The total SDQ scores were significantly higher among autistic children who experienced one or more online safety risks (n=30) ($M = 23.33$, $SD = 5.67$) than autistic children who were reported as having experienced no online safety risks (n=33) ($M = 19.82$, $SD = 6.27$), $p = 0.023$, confirming our expectations with a mid-range effect size, $d = 0.6$.

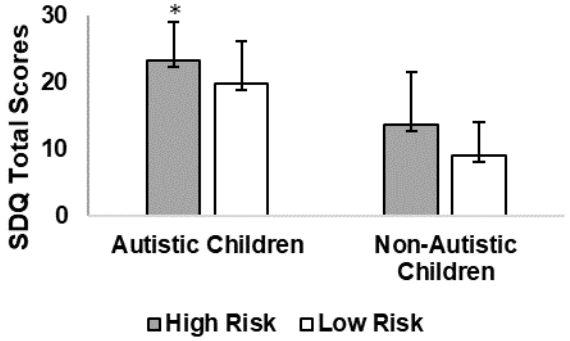
Similar results were found with the non-autistic group, with children who had experienced one or more online safety risks (n=13) having higher SDQ scores ($M = 13.77$, $SD = 7.71$), than those with no risks (n=28) ($M = 9.14$, $SD = 4.93$), with a mid-range effect, $d = 0.7$. However, the difference was non-significant, $p = 0.064$.

Table 3. Chi Square Tests of Child Risk Management Strategies Used According to Type

Online Risk Management Strategy	Pearson Chi Square χ2
Blocking people and/or online sites	9.538**
Asks others (including parent) for help	1.543
Relies on internet safety software	0.751
Unaware of what strategies he/she uses	0.755
Does not use any strategies	4.739*
Uses other strategies	0.026

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$

Figure 1. Group Differences in Child Wellbeing Scores



*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$

RQ5. Do parents of autistic children have lower parental self-efficacy than parents of non-autistic children who have experienced online safety risks?

A Mann Whitney U-Test was performed due to the difference in size between the two groups of parents. Parents of autistic children who completed the MAAP (n=61) reported significantly lower PSE scores ($M = 60.82$, $SD = 7.96$) than parents of non-autistic children who did not (n= 35), ($M = 65.11$, $SD = 7.96$), $p = 0.016$, $d = 0.6$, confirming our hypothesis with a mid-range effect size.

A Mann Whitney U-Test was used to analyze if there was a significant difference in PSE between parents of autistic children who have experienced one or more online safety risks and those who have not. Parents of autistic children (n=30) who have experienced one or more online safety risk reported lower total PSE ($M = 58.48$, $SD = 6.81$) than parents of non-autistic children (n=11) ($M = 59.74$, $SD = 7.64$), but the difference was non-significant, $p = 0.50$, $d = 0.2$.

A linear regression analysis was calculated to predict the impact of autism diagnosis, parental age, child age, child gender and parent's online safety knowledge on total MaAP scores. The model emerged significant, $F(5, 86) = 8.600$, $p = 0.000$, accounting for 29.5% the variance (Adjusted $R^2 = 0.295$). The unstandardised and standardised regression coefficients are displayed in Table 4. Autism diagnosis and parental online safety knowledge emerged as significant predictors of total MaAP scores, but the others were non-significant.

RQ6. Is there a relationship between total online safety risks experienced and total time spent using online devices?

A Pearson Correlation was conducted to investigate if there was a significant positive correlation between total online safety risks experienced and total time spent using online devices. No significant correlation was found, n=104, $r = 0.133$, $p = 0.180$.

Additional Pearson Correlation analyzes were carried out to investigate if significant correlations existed between total online safety risks and other variables. There was a significant positive correlation between child age and total online safety risks reported, n=104, $r = 0.227$, $p = 0.020$.

Table 4. Regression coefficients for variables entered into the RQ5 model (n=92)

Predictor Variable	B	SE B	B
Autism Diagnosis	-3.103	1.554	-0.195*
Child Age	0.305	0.225	0.141
Child Gender	-2.371	1.605	-0.144
Parent Age	0.154	0.086	0.176
Parent Online Safety Knowledge	1.809	0.361	0.484***

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$*

5 Discussion

We discuss our results related to each hypothesis below.

H1. Our aim was to investigate online safety behaviors of autistic children, according to the parents perceptions. In particular, we were interested in finding out if autistic children experienced more types or overall online safety risks than non-autistic children. It was hypothesized that there would be a difference between the two groups. Parents of autistic children reported them as significantly more likely to experience more overall online safety risks compared with the control group. This corresponds with previous literature suggesting that autistic adults may experience different online safety risks to varying degrees [22,44,52,58].

The autistic children with LD/ADHD experienced fewer online safety risks than non-autistic and autistic children without LD/ADHD, respectively ($\eta^2 = 0.395$). It is possible that this group experiences fewer risks because they are more protected due to the co-morbidity of multiple conditions. Moreover, this suggests an increased vulnerability to online safety risks is autism-specific. Therefore, future interventions should be designed with care and be cautious when stating the target population e.g. autistic children without LD.

Interestingly, when we examined associations between having autism and individual "types" of online safety risks, autistic children were significantly more likely to buy goods/services online. This is supported by research which utilised parental focus groups [22]. Our results suggest that autistic children are susceptible to this risk. Previous research suggests that special interests are important to autistic people [16]. It is possible that a desire to purchase items/services relating to them online makes this group more susceptible to unauthorized purchases. Therefore, future interventions should consider helping autistic children and parents become aware of this issue and what to look out for in terms of how money can be taken out of their online without their knowledge and steps available to prevent this.

Cyberbullying and sexual exploitation were not significantly associated with having autism. This contrasts with the few past studies conducted in this area [25,52,58]. It is possible that autistic children have less direct contact with others online. Mazurek and Wenstrup reported that autistic children compared with their non-autistic siblings spent more time watching television, playing videogames, but less time using social media or socially interactive videogames []. It may be that autistic children spend less time interacting with others online compared with their non-autistic counterparts, thereby reducing the likelihood of online bullying and sexual exploitation.

On one hand, it is possible that contact risks are not as prevalent in the autistic population as originally thought. Alternatively, it is possible that parents may have underestimated the prevalence of contact risks. Some studies have suggested that parents may underestimate incidents of cyberbullying in neurotypical children [7,62]. No research to date has directly investigated this among parents of autistic children, so it is unknown whether this pattern carries over to the latter. We are currently conducting follow up interviews with autistic young people aged 11-17 years about their online safety experiences. This will allow us to investigate the extent to which they report online safety risks experiences, including contact incidents. Based upon our current results and other findings, we recommend caution before piloting interventions without consulting with autistic young people and their parents.

Having autism was not associated with a reduced likelihood of phishing risks. Nevertheless, one previous study reported no evidence of a more systematic approach in autistic children compared with non-autistic children when they compared foraging behaviors [47]. Therefore, it is possible that autistic children are not less prone to experiencing content risks compared with non-autistic children. Alternatively, the heterogeneity in our sample may have accounted for these findings. Our study is one of the few which have compared rates in the autistic population [44]. In addition, it is the only study that we are aware of that has compared phishing incidents in autistic children. It is important that more research investigates this among autistic children before implementing interventions, particularly if results suggest that this is not the greatest risk, if at all, to autistic children. To summarise the outcome of the first hypothesis (H1), our results suggest that autistic children are more vulnerable to certain risks online.

H2. We expected that parents of autistic children would report them as less likely to carry out overall online safety risk management than non-autistic children. On one hand, there was no significant difference in total child risk management scores between the two groups. However, there were significant associations between having autism and not blocking people and/or online sites or using strategies to protect themselves online. The autistic group were almost 5 times less likely to block people and/or online sites compared with the non-autistic group. These results suggest that autistic children may find the prospect of the potential conflict of blocking people online overwhelming so avoid it more than non-autistic children. Compared with non-autistic children, autistic children have been reported to use social media less [37]. This may mean that autistic children are less aware of and adept with steps and/or digital tools for blocking people and sites. More work is needed to design interventions to enable autistic children to feel more confident independently managing unwanted online contact/content. Moreover, they were almost 8 times less likely to use strategies to protect themselves online. This highlights that a large number of autistic children are not in control of keeping themselves safe online. It is important that autistic children can be independent online as much as possible. Our findings support H2 and highlight that future interventions should focus on improving the ability of autistic children to protect themselves online, in particular block people/and or sites.

H3. Further, we predicted that there would be a difference in total parental online safety management between parents of autistic and non-autistic children. Parents of autistic children carried out significantly less overall parental risk management than the non-autistic parents. On one hand, our findings refute those from studies suggesting that parents of autistic children restrict their online device use more than non-autistic children [38,57]. On the other hand, it is possible that a reduction in parental risk management is indicative of a parent's reduced confidence in their capacity to protect their child online. Therefore, future interventions should focus on involving parents of autistic children in online safety programmes to help improve their knowledge and confidence handling online risks and involvement in the online protection of their autistic children.

H4. We hypothesised that autistic children who experienced more online safety risks would have higher SDQ scores than autistic children with lower total online safety risks. Higher SDQ total scores indicate poorer child wellbeing. It was important to establish if there was an effect of autism group and online safety risk group on total SDQ scores. There was a significant main effect of each on SDQ scores, with large effect sizes respectively, $\eta^2=0.395$; $\eta^2=0.096$. SDQ scores were significantly higher among autistic children who experienced one or more online safety risks than autistic children who were reported as having experienced no online safety (Cohens d=0.5). Similar results were found with the non-autistic group, with children who had experienced one or more online safety risks having significantly higher SDQ scores than those with no risks (Cohens d=0.7). This highlights that having a higher SDQ may mean that this group is more vulnerable to risks. These are backed up by previous studies indicating the negative consequences that risks such as cyberbullying can have on mental health in the autistic population [72,73]. This indicates that there may be

a more negative impact on autistic children, thus highlighting the importance of conducting research to reduce online safety risks in this population. Overall, our results suggest that autistic children are at risk of experiencing poorer wellbeing than non-autistic children, and this deteriorates if they experience online safety risks. It is paramount that work is done to address this issue. Researchers can measure autistic children's wellbeing pre- and post-intervention to investigate if there is an improvement following future online safety intervention(s).

H5. We expected that parents of autistic children would report lower PSE than parents of non-autistic children and subsequently found this to be true in our study. Parents of autistic children who had experienced one or more online safety risk reported lower total PSE than parents of non-autistic children who had experienced risks, but the difference was non-significant. Variance in PSE scores were significantly accounted for by autism diagnosis and parental online safety knowledge. This recognises the impact of having an autistic child and online safety knowledge on PSE. This highlights the need for interventions that improve online safety knowledge among parents of autistic children. Currently, parents tend to rely on self-guided online searches, as opposed to systematic and well-researched resources [71].

Future intervention designs should consider scaffolding autistic children's online safety knowledge as well as facilitating the active involvement of their parents [18]. It is important that this is done in consultation with autistic children and their families. A recent review of autism and technology use called for looking closely at how autistic children can be involved in the technology design process [63]. This is supported by a study from Putnam et al [49] who interviewed parents, teachers and other clinicians about autism and technology use. The interviewees highly valued research supporting efficacy. Therefore, it is important that interventions have the research basis to support them and are co-designed with the target population where possible.

H6. Interestingly, there was no significant correlation between total online safety risks and total online device use ($p > 0.05$). This emphasises that future research should consider moving away from screen time as an indicator of online vulnerability. Autistic children are active online users, but it is possible that time spent using online devices is not a robust predictor of online safety risks experienced. Furthermore, large scale survey evidence suggests that autistic children do not differ in their media use compared to other children [41]. Therefore, this must be considered in future studies. Online safety interventions should move away from restricting children's screentime as a means of protecting children online. This will help to nurture children's independence, in particular for autistic children to socialize and pursue interests online that are important to them.

6 Limitations

It is unclear to what extent the survey data can be generalised. Our results focused on parental perceptions of their children's online safety risks, which may not capture all online safety risks experienced by children. We recruited via the opportunity sampling method, which has incurred some bias. However, low numbers of autistic children diagnosed in the UK, in particular those with regular access to online devices meant that it would have been unrealistic for us to recruit in another way without running a high risk of low numbers which would have biased our results to a larger extent. The surveyed autistic group was majority-male and had high co-morbid rates of LD/ADHD. In addition, low numbers of risk incidences reported by parents may have reduced the power of our analyses. However, our data correspond strongly with existing literature reporting on individual autistic online safety risks and emergent findings regarding child and parental risk management. We add to this literature with an empirical investigation of multiple online risks in autistic children and comparing with non-autistic children.

Future studies should consider replicating our methodology with more autistic girls and conducting mixed methods investigations to examine this area in more depth. Further, researchers should investigate the differences in online vulnerability for autistic children versus autistic children with other co-morbid conditions, such as LD or ADHD. In addition, considering that there are distinct autistic gender profiles [33], varying interventions can be designed to help autistic girls and boys based on the likelihood of them experiencing a particular online safety risk. Nevertheless, further research is warranted before drawing firm conclusions regarding this matter.

7 Conclusion and Future Work

Overall, our work highlights that parents perceive that autistic children experience significantly more online safety risks than non-autistic children and are subject to poorer wellbeing than autistic children who did not experience online safety risks. It is crucial that more work is done to address these differences. Parents of autistic children reported poorer PSE and carried out significantly less risk management. Having an autistic child and parental online safety knowledge were significant predictors of PSE. Future design interventions should help improve autistic children's and parent's confidence in their online risk management, ideally in a co-participatory set up.

Recent reviews of autism and technology have reported no studies examining online safety in autistic children [63]. Without investigating this, it is impossible to inform ecologically valid design recommendations for autistic children and their families. Parental surveys provide a useful outlet to investigate the online safety behaviours and wellbeing of autistic children, particularly those with comorbid conditions.

- To the best of our knowledge, this is the first study to empirically compare multiple online safety risks and behaviors by autistic and non-autistic children.
- The survey findings will support the design of digital tools to aid autistic children's and parents' online safety decisions.
- Consequently we hope that this research will shape the direction of future interventions and policy for this population and thus will help protect autistic children online.

In light of our findings, our paper makes the following practical and design specific recommendations with regards to future online safety interventions for autistic children:

- Further research regarding contact risks e.g. cyberbullying and online exploitation is warranted before specific technological interventions are designed to ensure they are reflective of autistic children's online safety experiences;
- Researchers should look specifically at conduct risks (e.g. unauthorized purchases and why autistic children may be particularly vulnerable to them to help inform designers of future interventions; Parents, practitioners and policy makers should avoid inferring screentime with elevated online vulnerability among autistic children;
- Future online safety interventions, e.g. blocking people and/or sites will be more readily accepted and ecologically valid if they are co-designed with autistic children and their parents.

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